Pohutukawa x Rata No. 2

Variation in *Metrosideros* (MYRTACEAE) in New Zealand.

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ABSTRACT.

Hybrid indices have been prepared for samples of pohutukawa *(M. excelsa)* and Rata *(M. robusta)* from seven localities and are compared with indices for herbarium collections. It is suggested that variation in the samples is due to introgressive hybridization. The importance of recent volcanic activity, as well as man and his animals in clearing the land and providing new habitats for plant hybrids, is stressed.

INTRODUCTION.

The Christmas tree or pohutukawa *(Metrosideros excelsa* Sol. ex Gaertn., formerly known as *M. tomentosa* Rich), is common on the coasts of northern New Zealand and so picturesque when in flower at Christmas that it is a feature of all illustrations of coastal scenery. The rata *(M. robusta),* is also very well known because its flowers brighten the forest canopy in both the North and South Islands and its role as a "killer" or "strangler" of the tree on which it begins life as an epiphyte has been described in all popular books on New Zealand plants. Almost every year variation in the time of flowering of pohutukawa is recorded in letters and news items in the press. Sometimes correspondents draw attention to the fact that the colour of the flowers of particular trees is lighter or darker than usual and a comparison of the leaves of a number of pohutukawa trees will show at once that they vary considerably. Less frequently the flowering of the rata is the subject of comment.

MATERIAL STUDIED.

Herbarium specimens of *Metrosideros* were obtained from the principal New Zealand herbaria:

The Cheeseman Herbarium, Auckland Museum (AK)
The Dominion Museum, Wellington (WELT)
The Botany Division, D.S.I.R., Christchurch (CHR).

I am indebted to the Directors of the Dominion Museum and Botany Division, D.S.I.R., Christchurch, for the loan of material.

Mass collections were gathered during the brief flowering season in December-January, and in the winter months of April-June when fruit are ripe. I am grateful to the following for collections: Mrs. P. H. Hynes and Mr. T. Wilson (Mayor Island), Mr. R. Ward (Taupo), and the N.Z. Forest Service (Westport). For each mass collection from Rangitoto Island, Blockhouse Bay and the Bay of Plenty district I gathered 35 specimens which is barely sufficient to

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show the pattern of variation. I have included the smaller collections from Mayor Island (Mrs. Hynes), Taupo and Westport as they are of great interest. I must also express thanks to Mr. J. Diamond for the loan of old maps and references to the early history of Blockhouse Bay-Te Whau district, and to the Royal Society of New Zealand for a grant from the Hutton Fund for travelling expenses.

The Measurement of Flowering Specimens.

Tables 1-5 below have been prepared for five characters of each flowering specimen. The five characters are defined for purposes of measurement:

1. "Leaf length" is the length of the leaf at the second node below the apex of a mature woody branchlet bearing the flowering shoot.
2. "Leaf width" is the width of the leaf measured for length.
3. "Internode length" refers to the third internode of the shoot.
4. "Stamen length" refers to the length of the stamens of a fully-open flower in the centre of a cyme.
5. "Calyx-tube length" refers to the length of the calyx of the flower measured for stamen length.

DISTRIBUTION OF VALUES FOR LEAF LENGTH.

Table I.

Numerical index cm.	2.0–2.9	3.0–3.9	4.0–4.9	5.0–5.9	6.0–6.9	7.0–7.9	8.0–8.9	9.0+
Index value	1	1	2	2	3	3	4	4
HERBARIUM SPECIMENS:								
M. excelsa ..		1		4	8	4	2	1
x. *subtomentosa*		7	9	4				
M. robusta ..	7	14	6					
var. *retusa* ..	2							
MASS COLLECTIONS:								
Rangitoto Is.								
(Southern slope)		1	2	6	13	11	1	1
(Eastern slope)		3	5	5	10	9	2	1
Blockhouse Bay				6	14	11	4	
Mayor Is. ..						6	2	
Bay of Plenty			2	6	7	15	4	1
Taupo ..	1	3	6	3	1			
Westport ..	2	7	3					

DISTRIBUTION OF VALUES FOR LEAF WIDTH.

Table II.

Numerical index cm.	.6–1.0	1.1–1.5	1.6–2.0	2.1–2.5	2.6–3.0	3.1–3.5	3.6+
Index value ..	1	1	2	3	3	4	4
HERBARIUM SPECIMENS:							
M. excelsa ..			1	10	8	1	
x. *subtomentosa* ..		5	12	3			
M. robusta	4	19	4				
var. *retusa*			2				

MASS COLLECTIONS:							
Rangitoto Is.							
(Southern slope) ..		1	10	13	11		
(Eastern slope) ..		1	12	15	7		
Blockhouse Bay ..			2	16	15	2	
Mayor Is.			1	5	2		
Bay of Plenty ..			3	8	12	8	4
Taupo		5	8	1			
Westport	1	11					

DISTRIBUTION OF VALUES FOR INTERNODE LENGTH.

Table III.

Numerical index cm.	-.9	1.0–1.1	1.2–1.3	1.4–1.5	1.6–1.7	1.8–1.9	2.0–2.1	2.2–2.3	2.4+
Index value	1	1	2	2	3	3	4	4	4
HERBARIUM SPECIMENS:									
M. excelsa ..	1	1	1	3	5	3		2	4
x *subtomentosa*	3	4	6	1	1	3			2
M. robusta ..	4	4	9	6	2	2			
var. *retusa* ..							1	1	
MASS COLLECTIONS:									
Rangitoto Is.									
(Southern slope)	5	11	11	6	2				
(Eastern slope)	14	10	8	1	1	1			
Blockhouse Bay		3	6	8	7	6	5		
Mayor Is. ..					1	5	2		
Bay of Plenty		1	2	9	7	6	4	3	3
Taupo ..	2	4	5	2	1				
Westport ..	3	4	2	2		1			

DISTRIBUTION OF VALUES FOR STAMEN LENGTH.

Table IV.

Numerical index cm.	– .8	.9–1.2	1.3–1.6	1.7–2.0	2.1–2.4	2.5–2.8	2.9–3.2	3.3+
Index value	1	1	2	2	3	3	4	4
HERBARIUM SPECIMENS:								
M. excelsa ..			3	3	6	8		
x *subtomentosa*		5	9	6				
M. robusta ..	6	18	3					
var. *retusa* ..		2						
MASS COLLECTIONS:								
Rangitoto Is.								
(Southern slope)				2	7	18	8	
(Eastern slope)		2	2	3	6	13	9	
Blockhouse Bay				6	10	11	6	2
Mayor Is. ..					1	7		
Bay of Plenty				9	14	10	2	
Taupo ..		3	7	4				
Westport ..	6	6						

DISTRIBUTION OF VALUES FOR CALYX LENGTH.

Table V.

Numerical index cm.	.5	.6	.7	.8	.9	1.0	1.1	1.2+
Index value	1	1	2	2	3	3	4	4
HERBARIUM SPECIMENS:								
M. excelsa ..			2	5	6	5	2	
x. *subtomentosa*	1	5	10	4				
M. robusta ..	4	13	7	3				
var. *retusa* ..			2					
MASS COLLECTIONS:								
Rangitoto Is.								
(Southern slope)			1	1	6	18	7	2
(Eastern slope)	2	2	3	6	11	9	2	
Blockhouse Bay			1	8	8	11	4	3
Mayor Is. ..					1	6	1	
Bay of Plenty			1	5	5	11	11	2
Taupo ..	1	4	3	2	3	1		
Westport ..	1	8	3					

The Measurement of Fruiting Specimens.

Tables 6-10 below show the distribution of values for five similar characters of the fruiting specimens. The characters are defined:

1–3 "Leaf length," "Leaf width" and "Internode length," as in the flowering material.

4. "Capsule length" is the length of a ripe capsule, including the calyx and pedicel, in the centre of a mature fruiting branch.

5. "Capsule width" is the width of the same capsule measured at the calyx lobes.

DISTRIBUTION OF VALUES FOR LEAF LENGTH.

Table VI.

Numerical index cm.	2.0–2.9	3.0–3.9	4.0–4.9	5.0–5.9	6.0–6.9	7.0–7.9	8.0–8.9	9.0+
Index value	1	1	2	2	3	3	4	4
HERBARIUM SPECIMENS:								
M. excelsa ..				2	3	2	1	
x *subtomentosa*			1	1				
M. robusta ..	6	14						
MASS COLLECTIONS:								
Rangitoto Is.								
(Southern slope)			4	5	9	13	3	1
(Eastern slope)		2	5	15	9	3	1	
Blockhouse Bay				4	12	10	7	2
Mayor Is.								
(Hynes collection)				1	2	3	4	
(Wilson „)					7	14	10	4
Bay of Plenty				5	13	13	3	1
Taupo ..		2	3	1	1			
Westport ..	1	6	3					

DISTRIBUTION OF VALUES FOR LEAF WIDTH.

Table VII.

Numerical index cm.	.6–1.0	1.1–1.5	1.6–2.0	2.1–2.5	2.6–3.0	3.1–3.5	3.6+
Index value	1	1	2	3	3	4	4
HERBARIUM SPECIMENS:							
M. excelsa			1	2	5		
x *subtomentosa*		1	1				
M. robusta	7	13					
MASS COLLECTIONS:							
Rangitoto Is.							
(Southern slope)			9	15	6	5	
(Eastern slope)		4	7	14	8	1	1
Blockhouse Bay			1	15	12	6	1
Mayor Is.							
(Hynes collection)				4	4	2	
(Wilson „)				5	10	7	13
Bay of Plenty			1	13	15	6	
Taupo		4	3				
Westport	1	8	1				

DISTRIBUTION OF VALUES FOR INTERNODE LENGTH.

Table VIII.

Numerical index cm.	–.9	1.0–1.1	1.2–1.3	1.4–1.5	1.6–1.7	1.8–1.9	2.0–2.1	2.2–2.3	2.4+
Index value	1	1	2	2	3	3	4	4	4
HERBARIUM SPECIMENS:									
M. *excelsa*			1	1	2	2	1		1
x *subtomentosa*				2					
M. robusta	4	4	5	5	2				
MASS COLLECTIONS:									
Rangitoto Is.									
(Southern slope)	1	6	7	6	6	5	3		1
(Eastern slope)	3	4	15	8	4		1		
Blockhouse Bay				12	11	5	4		3
Mayor Is.									
(Hynes collection)				4	1	2	2	1	
(Wilson „)			3	6	5	3	3	3	12
Bay of Plenty			2	5	8	5	6	2	7
Taupo		2	3	2					
Westport	1	3	4	1		1			

DISTRIBUTION OF VALUES FOR CAPSULE LENGTH.

Table IX.

Numerical index cm.	.6–.7	.8–.9	1.0–1.1	1.2–1.3	1.4–1.5	1.6+
Index value	1	1	2	3	4	4
HERBARIUM SPECIMENS:						
M. excelsa			4	4		
x *subtomentosa*				2		
M. robusta	5	14	1			

MASS COLLECTIONS:						
Rangitoto Is.						
(Southern slope)		4	9	16	4	2
(Eastern slope)		4	17	12	2	
Blockhouse Bay		4	8	20	3	
Mayor Is.						
(Hynes collection)			2	4	4	
(Wilson „)				8	11	16
Bay of Plenty			12	16	5	2
Taupo	2	5				
Westport	2	4	4			

DISTRIBUTION OF VALUES FOR CAPSULE WIDTH.

Table X.

Numerical index cm.	.3–.4	.5–.6	.7–.8	.9–1.0	1.1–1.2	1.3+
Index value	1	1	2	3	4	4
HERBARIUM SPECIMENS:						
M. excelsa			2	4	2	
x *subtomentosa*			2			
M. robusta	13	7				
MASS COLLECTIONS:						
Rangitoto Is.						
(Southern slope)		1	4	15	15	
(Eastern slope)		1	6	20	7	1
Blockhouse Bay			3	10	18	4
Mayor Is.						
(Hynes collection)				1	8	1
(Wilson „)				3	28	4
Bay of Plenty				22	13	
Taupo	1	2	4			
Westport	9	1				

THE HYBRID INDICES.

The technique of preparing an index was described by Anderson (1949) and Sibley (1950), and has been discussed by Sibley (1954), Stebbins (1950, 1956) and others. Readers are referred to these papers for a description of the technique and a discussion of its value. For each of the characters measured four gradations have been indicated by the numbers 1, 2, 3 and 4. Any character expressed as fully as in rata is scored as "1," one expressed fully as in pohutukawa is scored as "4." Intermediates between the putative parents are scored either as "2" or "3." With five characters, each with a possible variation from 1 to 4, the summation of the characters of each specimen will fall between 5 and 20. Average hybrid numbers, being the mean of the index numbers, have then been calculated. In Fig. 1 the hybrid indices of flowering and fruiting specimens have been plotted as frequency diagrams and the average hybrid numbers are linked by vertical lines.

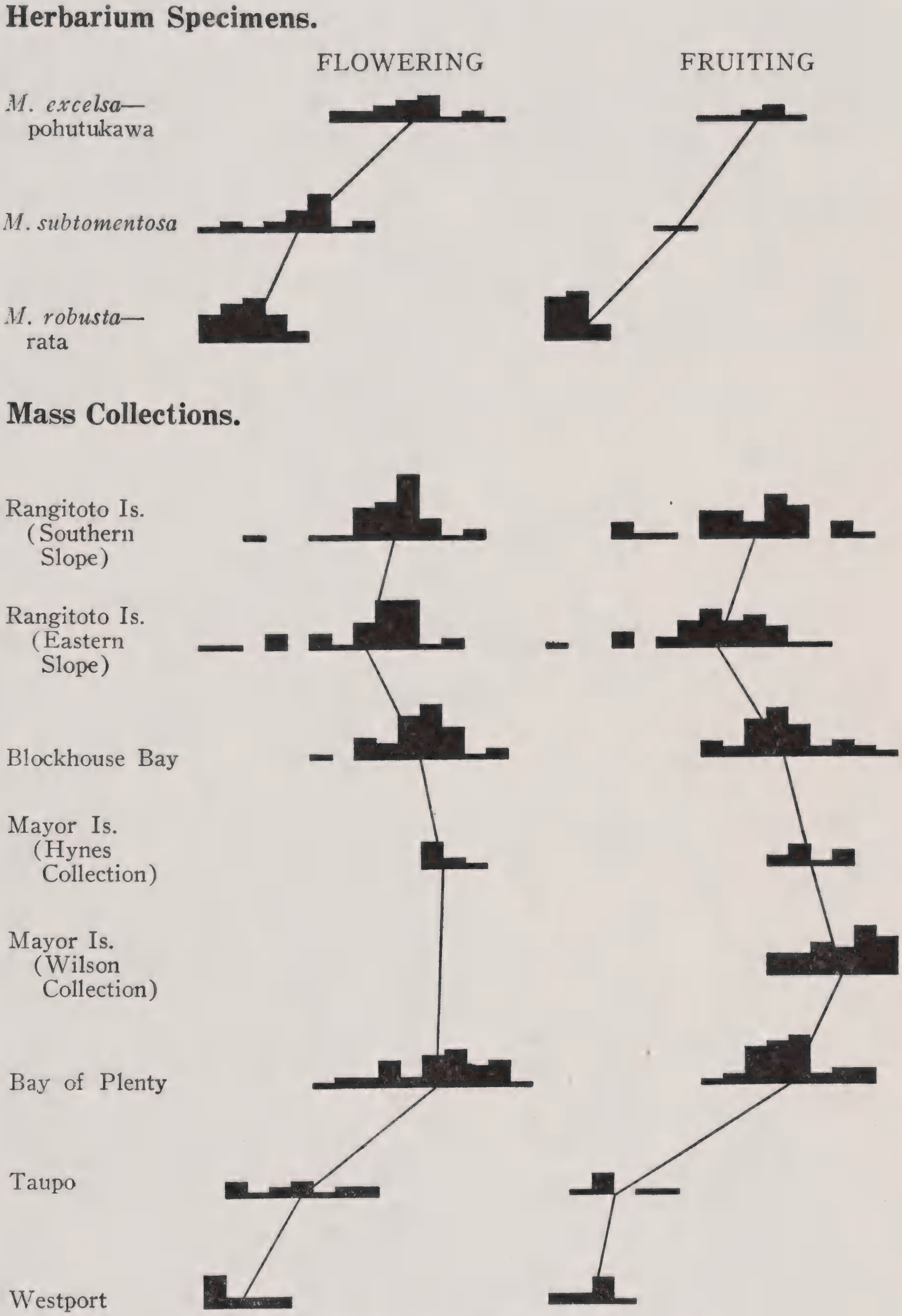

Fig. 1 Hybrid indices of Metrosideros.

HERBARIUM COLLECTIONS.

Most of the herbarium specimens which I have measured in this paper were identified by Kirk, Cheeseman, Cockayne, Petrie, Carse and Oliver, the leading New Zealand botanists of the past eighty years. These men recognised three main taxa: Pohutukawa *(M. excelsa,* formerly *M. tomentosa*), rata (*M. robusta*), and intermediates between these two species, now known as *M.* x *subtomentosa.* It is evident that they held almost similar views on the boundaries of the three taxa. Kirk labelled some specimens as "intermediates" which seem to belong to rata, but he was a keen observer who noted and drew attention to minor differences.

The range of the hybrid index numbers for the specimens is:

M. excelsa,	flowering specimens	11–18	
	fruiting specimens	12–16	
M. x *subtomentosa,*	flowering specimens	5–12	
	fruiting specimens	10–11	(only 2 sheets)
M. robusta,	flowering specimens	5–9	
	fruiting specimens	5–7	
var. *retusa*		10	(only 2 sheets)

The average hybrid index numbers are:

M. excelsa,	flowering specimens	14.2	
	fruiting specimens	14.2	
M. x *subtomentosa,*	flowering specimens	9	
	fruiting specimens	10.5	(only 2 sheets)
M. robusta,	flowering specimens	6.7	
	fruiting specimens	5.7	
var. *retusa*	flowering specimens	10	(only 2 sheets)

In the lists of specimens measured, appended to this paper, a specimen of *Metrosideros* has been included from the Three Kings Islands. Cheeseman (1891:421) recorded both *M. excelsa* and *M. robusta* from the group and remarked (ibid:418) that "pohutukawas are seen all round the island, but in small numbers, and dwarfed and stunted compared with their usual size on the mainland." The single collection from this population is included in the flowering specimens of *M. excelsa* as the stamen and calyx measurements are high. It has an index value of only eleven however and is dwarfed in leaf size. The other specimen of pohutukawa in this index with a value of eleven is from a cultivated plant at Rangaunu Harbour. It is most remarkable in possessing yellow flowers. If these two aberrant plants are eliminated, the obvious gap between the ranges of *M. excelsa* and *M. robusta* is widened by a further unit.

In the lists of specimens measured only two fruiting specimens of *M.* x *subtomentosa* have been included. In preparing the tables of measurements however I omitted several collections from Rangitoto Island, labelled as intermediates, as they appeared to be duplicates taken from the same plant. In the lists only one specimen of *Metrosideros* has been included from the West Coast of the North Island of New Zealand. Although it is well known that *M. excelsa* is common in many localities on the West Coast, there are no other herbarium collections. The existing herbarium material does not support the distribution of *M. excelsa* given by Cheeseman (1925:594) and does not indicate the variation present in different populations. With increasing land settlement and urban spread the remaining areas of indigenous vegetation are being reduced and modified very rapidly and there is an urgent need for the collection and preservation of representative samples of local plant populations.

MASS COLLECTIONS.

Rangitoto Island.—In a previous paper (Cooper 1954a:205) I mentioned that Rangitoto Island is a circular volcanic cone in the Hauraki Gulf at the entrance to Auckland Harbour. Cheeseman (1922:20) gives the following excellent description of the island: . . . "The whole of the island, except the cinder cone with its wonderfully well-preserved crater, consists of lava-streams with an average inclination of from 4° to 6°. Of the 5,600 acres which make up its area, more than 5,000 are occupied by these streams. Their surface is everywhere rough and difficult to traverse, being composed of masses of basalt of all sizes and shapes, rough and sharp-edged, and piled into ridges separated by irregular depressions or chasm-like holes. That the lava is comparatively recent is evident; and good judges have estimated that not more than five hundred or six hundred years have elapsed since the close of volcanic activity. No streams of water exist nor could such be expected, as the heaviest rainfall is at once absorbed by the porous surface. Seen from the distance the greater part of the island appears to be covered with a low scrubby forest, but once on shore it is found that there are considerable areas almost bare of vegetation except a few lichens and mosses . . ."

"The most abundant tree is the 'Christmas tree' or pohutukawa [*Metrosideros excelsa*] which probably constitutes four-fifths of the ligneous vegetation. . . ."

Millener (1953:17) has described the pohutukawa forest as follows:

"There are still large areas of broken lava separating rather well-defined 'islands' of vegetation. These 'islands' are coalescing and most are actively growing. . . . New 'islands' are constantly forming and provided the past rate of progress is maintained another century would see almost all of the bare areas on Rangitoto covered. . . ." He has counted up to 130 rings in cross-sections of old specimens of *M. excelsa* and considers that 150-200 years may be taken as the maximum age of any tree on the island. He has listed a considerable amount of evidence to support his thesis that the present vegetation is little more than two hundred years old.

Of the trees themselves Kirk (1879:450) has written as follows: "On the clay cliffs of the adjacent islands *Metrosideros tomentosa* attains a height of from fifty to eighty feet, with a trunk from two to three feet in diameter; in its natural condition it rarely flowers before attaining the height of from twenty to thirty feet, but on Rangitoto compact charming specimens one to three feet high were covered with brilliant flowers; scarcely a plant was to be seen over twelve feet in height, but nearly all were splendidly in flower. Near the base of the cone I observed two specimens of a peculiar form of this species, with the leaves and flowers of smaller size than in the typical form; the leaves glabrous and coriaceous, closely approaching *M. polymorpha* . . . .*Metrosideros robusta* was less common than its close ally but occasionally attained a greater size. . . ."

From these quotations the ecological conditions, age and dynamics of the vegetations may be glimpsed.

Local patterns of variation were noted in my previous paper on *Metrosideros* (Cooper 1954a:208) and I remarked that the prevalence of individuals closely resembling pohutukawa was greater in the sample of flowering specimens from the southern slope of the island than it is in the sample from the eastern side. In the sample from the eastern side of the island there are more individuals resembling rata. The same pattern of distribution is seen in mass collections of fruiting material. The ranges of the index numbers are:

	Southern slope	*Eastern slope*
Flowering specimens	7–17	5–16
Fruiting specimens	8–19	5–17

The average hybrid index numbers are:

	Southern slope	*Eastern slope*
Flowering specimens	13.4	12.1
Fruiting specimens	14	12.3

Forest still covered parts of Motuihe and Motutapu as recently as 1870 and it is probable that the parents of *M. excelsa* and *M. robusta* on Rangitoto Island came from these two adjoining islands.

Blockhouse Bay.—This name includes collections made between Wattle Bay and Te Whau Point on the northern coast of the Manukau Harbour. Colenso (1844:58) recorded his impressions of this district in February 1842 as follows:

". . . we left Otahuhu in a small canoe . . . and paddling down the Bay about four miles, landed on the northern side of the harbour, and continued our course by the muddy winding shores of Te Wau, a little cove, where the path leading to Kaipara commenced. . . . Continuing our journey, I found, in ascending the first clayey hill from the sea-side, a handsome shrubby *Dracophyllum*. . . . We travelled on, over open and barren heaths, in a northerly direction, till sunset, but saw nothing new in these dreary and sterile wilds, save the *Dracophyllum* already noticed. Bivouacked for the night in a little dell, nestling among the close growing *Leptospermum;* not a stick being anywhere within ken large enough to serve as a tent-pole. Next morning we recommenced our journey in rain, the country for several miles being much the same as yesterday. About noon we passed some forests of *Dammara,* which were burning fiercely; some person or persons who had lately gone that way having set fire to the brushwood, which soon caught the forests. This is a very common occurrence in New Zealand, and often thoughtlessly done by the natives on purpose to cause a blaze by which means many a noble forest of Pines has been entirely consumed. . . ."

Old Land Claim 321, being a plan of lands situated at Titirangi in the County of Eden, Parish of Titirangi, belonging to W. F. Porter et al, surveyed by J. B. O'Mealy and dated 15th September, 1846, shows the Titirangi forest margin on the land claimed by Miss Alice Porter, near Oatoru, about two miles west of Te Whau Point, and running westwards close to the present-day position of the forest margin in Glen Eden Valley.

From the quotation, the survey plan, and the abundance of kauri gum in the soil at Blockhouse Bay, it is evident that kauri forest covered the land around Te Whau Point sometime prior to 1842. It is also evident that most of the forest was cleared, probably by fire, before 1842. The land remained in scrub until recent times, and I have been unable to find any specimens of rata *(M. robusta)* in the remnants of coastal forest preserved at Waikokowhai Domain and Duck Creek reserve. Rata is usually a forest tree, beginning life as an epiphyte, and the destruction of the forest prior to 1842 accounts for its absence.

The specimens of pohutukawa *(M. excelsa)* collected for this study were obtained from the trees which cling precariously to the crumbling cliffs of sandstone which form the northern boundary of the Manukau Harbour.

Their range in the hybrid index is:

Flowering specimens	10-18
Fruiting specimens	12-20

The average hybrid index number is:

Flowering specimens	14.5
Fruiting specimens	15.3

Clearly they are close to pohutukawa and show less variation than the collections from Rangitoto Island.

Carse (1927:92) described hybrids between pohutukawa and rata as *M.* x *subtomentosa* from specimens collected at the "Bank of Whau (tidal creek)," Titirangi, and Lake Taupo. From the herbarium labels it seems that Carse found a single tree in 1925 on the Waitemata side of the Whau portage, several miles from Blockhouse Bay, on an inlet running towards Glen Eden. Colenso's description indicates that the kauri forest (which would include rata, *M. robusta*), was cleared from this district prior to 1842, and the persistence of an obvious hybrid nearly a century later is remarkable. It is significant that Carse commented that the Whau plant was nearer to *M. tomentosa* (pohutukawa = *M. excelsa*) while the Taupo plant was closer to *M. robusta.*

Bay of Plenty.—Kirk (1897:512), in a description of the road from Opotiki to Gisborne in 1897, wrote that "between Hawai and the Motu River . . . the shingle beach is the only road. . . . About the beach rise cliffs and hills, the former almost or quite perpendicular. To these cliffs the pohutukawa clings with wonderful persistency. . . . From the Motu there is again a bridle track skirting generally the tops of the cliffs, and running through forests of pohutukawa. . . . [About Te Kaha] the numbers and warlike habits of the old populations are constantly recalled to mind by deep trenches and banks cutting off all suitable points of land as fortifications. In many of the trenches pohutukawas a foot or more in diameter are now growing. . . ."

Today a good motor road follows the coastline through land cleared and grassed for sheep and dairy farming but in many places remnants of the original mixed forest persist on the hills and a narrow belt of pohutukawa forest fringes the shore. Although rata, *M. robusta,* is present in the mixed forest on the hills, few intermediates between it and pohutukawa are found and the variation present in the samples is very similar to that seen in the collections from Blockhouse Bay.

The range of variation is:

Flowering specimens	10-19
Fruiting specimens	12-19

The average hybrid index number is:

Flowering specimens	15.1
Fruiting specimens	15.6

Mayor Island.—Thomson (1926:210) has described Mayor Island, a volcanic cone 1,274 ft. in height situated in the Bay of Plenty about 23 miles north-west of Tauranga. Recent age is evidenced by the structure of the island, the presence of hot springs and the specific character of the lavas. The pohutukawa, *Metrosideros excelsa,* dominates the areas of forest on the island, except in the valley bottoms where mixed forest prevails. Atkinson and Percy (1956:29) have published a map of the island vegetation and a description of the plant communities. From their discussion of the history of the vegetation the following extracts are taken. ". . . Embedded high up in the south-eastern crater wall are the charred remains of logs. These have been buried by an eruption of pumice and subsequently compressed by a more recent lava flow. . . . The presence of the logs shows that Mayor Island was colonized by vegetation at least once, and possibly several times, between periods of volcanic activity. . . ."

"That most of the vegetation of the island's outer slopes is less than 150 years in age seems certain. Gold-Smith (1884) giving a general description of the island's vegetation, says: 'Common fern, tutu, tea-tree (very thick), koromiko and a little grass, form the ordinary vegetation, whilst the few clumps of trees consist of pohutukawa, mapou, manuka, rewarewa, akeake, whau or corkwood, pukapuka, and a few puriri, which, however, is of little value being very scattered and ruined by fire.' The occurrence of extensive fires in the past is also suggested by the wide distribution of the *Leptospermum*/ emergent *Knightia* vegetation type which is characteristic of vegetational succession after fires on the mainland. This secondary status of the vegetation is not surprising, since the island is thought to have been densely settled by the Maori. . . . A more recent fire (after 1900) is mentioned by Bell (1914) who records that a large area of the western portion of the island was swept by fire which, however, did not enter the crater. . . ."

"Within the crater the *Leptospermum* vegetation of the eastern floor may be a regeneration stage after fire. . . . Elsewhere in the crater there is evidence of widespread fire. Charred stumps and pieces of charcoal are to be found at many widely scattered points through the forest. . . . Tissue macerations . . . of better preserved logs showed fibres similar to those of pohutukawa. Ring counts of *Leptospermum, Weinmannia* and pohutukawa taken at widely distributed points on the lower tholoid flows indicated ages between 40 and 70 years. The previous vegetation was therefore probably a pohutukawa forest, much of which was damaged or destroyed by a fire or fires which occurred at least 80 to 100 years ago. . . ."

From the excellent account of Atkinson and Percy it is clear that the pohutukawa forests of Mayor Island have been partly cleared away on a number of occasions by volcanic activity, Maori occupation, and more recent firing. The *Metrosideros* population is identified without hesitation however as *M. excelsa* (pohutukawa) and no other species of the genus has been recorded from the island.

The range of the index numbers of the collection gathered by Mrs. Hynes is:

Flowering specimens	15-17
Fruiting specimens	15-18

Average hybrid index numbers are:

Flowering specimens	15.5
Fruiting specimens	16.5

The range of index numbers in the collection made by Mr. T. Wilson is:

Fruiting specimens	15-20

The average hybrid index number is 17.9.

This material seems to represent pohutukawa *(M. excelsa)* growing under nearly optimum conditions. The absence of intermediate or hybrid forms is noteworthy and probably it is related to the absence of rata.

There is the possibility that the larger size and relative uniformity of the population is due to some climatic or edaphic factor peculiar to northern coastal islands. Cranwell and Moore (1935:310) remark that "there has been much speculation as to the significance of leaves of great dimensions and thick texture of several coastal islands," and consider that in some instances there is fairly definite correlation with environment while in at least one case genetical differences may be involved. Two or more species of *Metrosideros,* including always pohutukawa, are present on Little Barrier, Great Barrier, Hen and Chickens, Poor Knights and possibly the Three Kings Islands. The specimens of pohutukawa from these islands show some thickening of the leaves, but there is no obvious increase in leaf size. A few specimens appear to be typical hybrid intermediates between pohutukawa and rata. Only a few collections have been made however and most of the specimens lack flowers and fruits. It would be worthwhile to compare mass collections from these islands with similar population samples from Mayor and White Islands where only one species of *Metrosideros,* pohutukawa, has been collected.

Lake Taupo.—Hochstetter (1867:384) recorded that Motutaiko Island was said to be the only place in the Taupo district where the pohutukawa tree *(M. excelsa)* was still found. The island is halfway between the south and north ends of the lake and situated about a mile from the eastern shore. It has a long history of Maori occupation.

More recently further trees of the Taupo form of pohutukawa have been collected from the western shore of the lake at a locality known as Pohutukawa Bluff about two miles west of Te Karaka and Rangatira Point.

Hill (1905:458) describes Motutaiko as follows:

"The island . . . rises about 320 ft. above the present level of the lake. It is made up of some curious ropy lavas. . . . Capping the whole of the higher portion of the island is a deposit of pumice in places more than 60 ft. in thickness. . . . Along the beach further to the north-east of the island there are traces of submergence, for large timber trees can be seen in the water with their roots still fixed in the ground."

Kerry-Nicholls (1884:305) explored the Western Taupo in 1883 and found that a broad, open tableland, averaging in height from 1700 to 2200 feet above sea level, extended far inland along the whole western shore of Lake Taupo. Much of this tableland was covered with native grasses, save the lower hills, which were mostly clothed with fern. In the map appended to the narrative of his journey the country about Te Karaka and Rangatira Point is noted as "fern ridges."

Fletcher (1915:71) recorded that ". . . within the memory of men still living the old forests extended over a much greater area than at present. There is an old Maori now living at Oruanui who remembers the time when the Oruanui Forest extended right on to the edge of the Taupo Lake at Rangatira. The proof of this was to be seen all over that portion of the country up to the last few years. The remains of the burnt logs, mostly *Podocarpus totara,* were collected by the European residents of Taupo and used as firewood. . . ." Fletcher considered that the former large forests were destroyed by fires set by the Maori people to stimulate the growth of fern root, one of their staple foods in pre-European times.

Ward (1922:280) recorded old totara tree stumps submerged in varying depths of water, in all the bays on the North Shore of Lake Taupo, and considered that they had been brought there by comparatively recent subsidence along the shore. He was writing of the 1922 earthquakes which were connected with a subsidence of fully 12 feet in the strand-line of Whakaipo and Whangamata Bays (Grange 1932:141). These bays lie immediately west of Pohutukawa Cliffs.

From these quotations it is evident that both Motutaiko and Pokutukawa Cliffs have been subject to interference by man and by natural forces in recent times.

The range of index numbers is as follows:

Flowering specimens	6-12
Fruiting specimens	6-10

The average hybrid index number is:

Flowering specimens	8.9
Fruiting specimens	7.6

Clearly the population is very close to rata *(M. robusta),* and would be included in that species if the specimens did not show such marked variations in size and the occasional presence of tomentum on the underside of the leaves. Large leaves and white tomentum beneath the leaves are two distinguishing characters of adult pohutukawa *(M. excelsa).*

Westport.—The specimens in this collection were gathered at Te Kuha, Island Creek, Birchfield and Reefton. Te Kuha is situated on the lower Buller Gorge, six miles from Westport. It was a small Maori settlement until about 1890. Island Creek enters the Buller River on the south bank a short distance downstream from Te Kuha. Birchfield is a settlement 13 miles north of Westport near the coast. Reefton is situated on the Inangahua River, a tributary of the Buller. All these localities have a history of gold mining and sawmilling since European settlement began about 1860. The range of variation in the hybrid index is:

Flowering specimens	5-8
Fruiting specimens	5-8

The hybrid index numbers are:

Flowering specimens	6
Fruiting specimens	6.5

These values are the lowest obtained from the mass collections and match those for herbarium specimens of rata, *M. robusta.* The southern limits of the pohutukawa, *M. excelsa,* are as follows:

West Coast of the North Island—"mouth of the Mimi River" (Kirk 1889:238).

East Coast—"A headland north of Anaura Bay" (Moore—personal communication).

Kirk (1889:238) wrote that he had been assured "that this species is plentiful between Riwaka and Waitapu, on the southern side of Cook Strait . . . and that one or two trees are to be found on a point between Takaka mud-flats and Collingwood." There is a single sterile representative of this South Island population in the herbarium of the Dominion Museum, Wellington (Kirk No. 1023), and its measurements fall within the range of variation of herbarium collections of *M. robusta.* Can the Westport collection be regarded as typical *M. robusta?* Pohutukawa has reached its southern limit far to the north and its influence is absent. It is noticeable however that in several of the specimens in the collection the calyx tube is markedly elongated. This is a character of *M. lucida,* the southern rata, which is abundant from sea level to 2000 feet in the Westport district (Townson 1907:409). *Metrosideros robusta* has a similar distribution and it is possible that the collections include hybrids between the two but insufficient material is available for study.

DISCUSSION.

It would be difficult to demonstrate that the variation in the samples from Rangitoto Island is due to hybridization by direct genetic experiments as the time which elapses from seed to flowering for both pohutukawa and rata is more than a decade. It has been suggested to me that this difficulty could be overcome by raising seedlings and determining the proportions of pohutukawa and rata present from leaf characters. De Berg (1945:64) considered that most of the seed of the Rangitoto plants was fertile. Kirk (1889:237) recorded however that the leaves of young pohutukawas are perfectly smooth and closely resemble those of *M. robusta,* and De Berg (ibid:42) was unable to distinguish juvenile plants of pohutukawa from rata until they were about four years of age. Then the pohutukawas developed larger leaves with white tomentum on the underside. The rata leaves remained smaller and glabrous.

Efforts to obtain chromosome numbers have not been successful and possibly the numbers would not throw any light on the problem. This was our experience with *Pittosporum* where Rattenbury (personal communication) obtained the same chromosome number for all the species. For these reasons other methods have been used to study and describe the variation in the population.

In a previous paper on the *Metrosideros* of Rangitoto Island (Cooper 1954a) I presented pictorialized scatter diagrams which were similar in appearance to those of known hybrid populations. This confirmed the views of Cockayne, De Berg and others that pohutukawa and rata have crossed freely to produce the present population. In the tables and indices of this paper the measurements and values of reproductive characters are very similar to those for vegetative characters. For example the values for stamen length or capsule width in each population are similar in distribution to the values for leaf length. If the values for stamen length have a wide range those for leaf length also have a wide range. If the values for stamen length are low in the possible scale those for leaf length also approach the rata end of the distribution. In the circumstances I consider that dwarfing due to severe habitat conditions is not an important cause of the variation in the samples. A possible exception to this is seen in the herbarium material where a single specimen of pohutukawa from Great Island in the Three Kings group has the large flowers which are characteristic of *M. excelsa* and small leaves typical of an intermediate form. In the discussion of this collection however I mentioned that Cheeseman described the pohutukawa trees on the island as stunted and dwarfed.

Before considering the results obtained it must be emphasized that the hybrid index is a very crude device. One very serious fault of the index is that it is based on the measurements of comparatively small specimens which may not represent the individual trees from which they are taken. In some of the sampling a deliberate choice was made of the specimen to represent each tree but in other cases any scrap that could be gathered was taken. Another fault is that equal value is given to each character but it has been impossible to devise a system of weighting. I have been unable to decide whether a character such as internode length or leaf width is of greater or lesser value than calyx length.

The index enables only qualitative or verbal comparison to be made, but further definition of the properties of the frequency distributions does not seem worthwhile in view of the faults mentioned.

Despite these deficiencies, the classification of the measurements has made them comprehensible. The indices for the flowering specimens show definite patterns of variation and these are repeated in the diagrams of fruiting material.

The extent to which further samples should be drawn from each population is a problem that I have been unable to decide. The Rangitoto population has been sampled on the southern and eastern slopes of the island and local patterns of variation have been found. Further sampling of the population in the same localities has confirmed these patterns. They are sufficiently alike to give a picture of the variation on the island and further sampling of the population does not seem necessary for the purpose of this paper.

There are many more intermediates of hybrid origin in the samples from Rangitoto Island than in those from Blockhouse Bay and there seems to be a relationship between this and the history of the two populations. In the absence of rata any intermediates there may have been at Blockhouse Bay have backcrossed to pohutukawa with consequent loss of rata characteristics or have left no progeny.

Both Rangitoto and Mayor Islands are recent volcanic cones and both have a history of recent volcanic activity, fires and human interference, but there is a marked difference in the patterns of variation of the samples from each population. The absence of rata from Mayor Island seems to be the explanation of these differences.

At Taupo the population commonly called "pohutukawa" is very close to rata. Possibly the present appearance of the plants is due to a past cross between rata and pohutukawa and subsequent backcrossing to rata. The nearest population of typical pohutukawa is that at the Rotorua lakes and apparent intermediate forms have been collected at Lake Tarawera between Rotorua and Taupo. Past plantings by Maoris may be a factor in the present distribution.

The Bay of Plenty population has few intermediates although pohutukawa forest and mixed forest containing rata adjoin in many places. The absence of intermediates here is remarkable but the pohutukawa forest fringing the coast is relatively undisturbed and the areas cleared by Maori and pakeha settlement have been maintained in grassland.

Anderson (1953:289) has pointed out that the presence of hybrids and their significance in evolution is closely connected with the history of the land. He remarks that "the dependence upon suitable ecological niches, if hybridization is to have any important evolutionary consequence, has been demonstrated in various field studies. . . ." "All the evidence from sympatric introgression shows that such species are kept apart by ecological and internal barriers of various kinds. In old, well-established floras, until the ecological barriers are broken down, there will be little or no introgression no matter how weak the internal barriers because there are few intermediate niches for the first generation hybrids and virtually no niches for the various new recombinations produced in the second generation and in backcrosses. When man 'hybridizes the habitat,' as by burning, ditching, pasturing, tilling the soil, he produces new, and frequently relatively unoccupied niches in which introgressants are at a selective advantage. It is significant that most of the earlier field studies of hybridization were made at places where the ecological pattern of the environment had been grossly disturbed by man and his domesticated animals. This is particularly true of New Zealand, where the frequency of hybridization is so high as to have led to extensive studies by various naturalists (see Allan, 1937, for a review of the literature). The situation there may be briefly interpreted as follows: New Zealand had essentially an island flora which had evolved not only in the absence of man, but essentially in the absence of any higher vertebrates. The arrival of the Maori in the fourteenth century brought in fire, which they used deliberately in clearing fields for cultivation. These burns were usually deserted after a few years and abandoned to the native vegetation which moved in. White colonists arrived five hundred years later, bringing with them pigs, horses, chickens, cattle and sheep, and increasingly intensive methods of cultivation. Whenever a pig first rooted in the forest, whenever a piece of forest land was first burned over by the Maori, whenever a herd of cattle were loosed in a semi-wooded area, they were attacking a flora which not only had no association with such marauders throughout its history, but had even had no experience of much milder vertebrates. When pigs rooted in the turf, when cattle browsed upon vegetation, when trees were felled, new ecological niches were created which were outside the evolutionary experience of the entire New Zealand flora. Hybrids which had previously been spawned with a low frequency now had strange new habitats in which they and their variable backcrosses could grow without intense competition."

The extent of hybridism in the New Zealand flora is not known but a casual glance at the literature shows that there is much truth in Anderson's remarks. For example, the discovery of beech hybrids was made by Cockayne in 1921 when in the forest between Elfin Bay and Rere Lake (near the head of Lake Wakatipu), he "found everywhere such extreme diversity amongst adult trees, saplings and seedlings of the beeches . . . that the idea of excessive hybridization was at once suggested" (Cockayne 1926:10). In an introduction to Lotsy's lectures on evolution (Lotsy 1925:v) Cockayne described the find again as follows:

"It was in April 1921 that I had the good fortune while sauntering one evening in the beautiful forest near Elfin Bay, Lake Wakatipu, to accidentally find as the new growth, where certain trees had been burnt, a most diverse assemblage of sapling and seedling southern beeches (*Nothofagus*), few of which were alike, the great majority matching no known species. This at once suggested hybridization. . . ." The significant part of this story is that hybrids were found *where trees had been burnt.* While the role played by fire and human and animal interference in clearing the vegetation from the land and providing new and varied ecological niches can be substantiated, I think that this study indicates that recent geological change may be an important factor. If after land is cleared by volcanic eruption or other cause two potential parent species are present a diverse hybrid progeny may be expected. This is obviously the history of the pohutukawa x rata swarm on Rangitoto. It is also, I think, the history of the puzzling abundance of hybrid forms of *Dracophyllum* and *Gaultheria* on the central volcanic plateau.

In southern localities of New Zealand, where there has been no recent volcanic activity, the periglacial zone, described by Willett (1950:18), may have provided new habitats for plants of hybrid origin.

Table I.

Flowering Specimens of *Metrosideros* in New Zealand Herbaria.

Column 1. Leaf length, 2. Leaf width, 3. Internode length, 4. Stamen length, 5. Calyx length, 6. Hybrid index number.

M. excelsa Sol. ex Gaertn. ("Pohutukawa")

Herbarium	Collector	Locality	1	2	3	4	5	6
AK	Banks & Solander, —.		8.5	2.8	3.3	2.8	1.0	17
AK	Baylis, 22811.	Great Is., Three Kings Group	3.2	1.8	1.6	2.5	.8	11
AK	Lieth, 23335.	Rangiputa	5.6	2.5	2.6	2.4	.8	14
AK	Matthews, 5583.	Rangaunu Harbour	6.1	2.3	.9	1.4	.7	11
CHR	Zotov, 85008,	Paihia	6.0	2.3	1.7	2.7	.9	15
AK	Moore & Cranwell, —.	Tunnel Is., Poor Knights Group	5.6	2.6	1.7	2.4	.9	14
WELT	Kirk, 1013.	Blind Bay, Great Barrier Island	6.5	2.4	1.9	2.2	1.0	15
WELT	ex Col. Mus. herb., —.	Kawau	6.5	2.6	2.3	1.9	1.0	15
WELT	Mrs. Petrie, 5575.	Motutapu	9.2	2.7	1.5	2.8	.9	15
AK	Kirk, 184.	Waitemata	7.7	2.8	2.5	2.6	1.1	17
WELT	Kirk, —.	,,	6.3	2.9	3.6	2.2	.9	16
WELT	Kirk, —.	,,	7.2	2.6	1.2	2.4	.9	14
WELT	Petrie, —.	Rangitoto Is.	6.5	2.4	1.0	2.2	1.0	13
WELT	Petrie, —.	,,	7.7	2.2	1.7	1.6	.7	13
AK	Cheeseman, 5584.	Orakei	6.1	2.9	1.9	2.7	1.0	15
WELT	Petrie, —.	Auckland	5.8	2.5	1.7	1.8	.8	12
AK	Cooper, 36092.	Blockhouse Bay	8.3	3.2	1.8	2.8	1.1	18
WELT	Petrie, —.	Ruth's Is., Firth of Thames	5.7	2.5	2.2	2.0	.8	13
WELT	Petrie, —.	Thames	7.5	2.5	1.5	2.7	.9	14
WELT	Oliver, —.	Kawhia	6.6	2.5	1.5	1.6	.8	12

M. x *subtomentosa* Carse

Herbarium	Collector	Locality	1	2	3	4	5	6
WELT	Kirk, 1011.	Great Omaha	5.1	2.0	1.2	1.6	.7	10
CHR	Hutson, 59816.	Hills above Port Charles	4.9	1.7	1.2	1.8	.7	10
AK	Cheeseman, 5574.	Rangitoto Is.	3.4	1.6	1.8	1.3	.7	10
AK	Cheeseman, 5575.	,,	3.2	1.5	2.4	1.2	.8	9
AK	Cheeseman, 5576.	,,	3.4	1.4	.7	1.2	.7	6
WELT	Cheeseman, —.	,,	4.8	1.9	1.8	1.6	.8	11
AK	Cranwell, a.	,,	5.2	1.8	1.5	1.3	.7	10
AK	Cranwell, b.	,,	3.6	1.7	1.2	1.6	.7	9
AK	Cranwell, c.	,,	5.2	2.4	2.4	1.8	.6	12
AK	Cranwell, d.	,,	4.5	1.7	1.3	1.7	.7	10
AK	Kirk, 5593.	,,	4.2	1.6	.6	1.5	.7	9
AK	Kirk, 29481.	,,	3.5	1.4	1.0	1.2	.5	5
WELT	Kirk, 1022.	,,	3.4	1.4	.8	1.5	.6	6
WELT	Carse, —.	Tidal Creek, Whau River	4.1	2.2	1.8	1.9	.8	12
WELT	Aston, —.	Mt. Tarawera	4.6	1.3	1.7	1.4	.7	10
WELT	Aston, —.	,,	4.6	1.9	1.1	1.2	.8	8
CHR	Hill, 11565.	Rocky shores of Lake Taupo	4.3	1.6	1.2	1.5	.6	9
CHR	Hill, —.	,,	3.9	2.1	1.3	2.0	.7	10
WELT	Petrie, —.	Shores of Lake Taupo	5.4	1.9	1.1	1.2	.6	7
AK	Cheeseman, 5585.1.	Motutaiko Is.	4.9	1.6	1.1	1.8	.6	8

M. robusta A. Cunn. ("Rata")

AK	Matthews, 2531.	Ahipara	2.6	1.1	1.7	1.1	.5	7
AK	Matthews, 524.	Kaitaia	3.5	1.4	1.9	1.3	.7	9
WELT	Kirk, 159	Whangaroa	3.6	1.2	1.2	1.0	.7	7
WELT	Kirk, 1019.	Bay of Islands	2.8	1.1	1.1	.8	.5	5
WELT	Petrie, 5580.	8 miles north of Opanaki, Kaihu-Taheke Rd.	2.7	.9	1.4	.7	.6	6
WELT	Petrie, —.	Kaihu, north of Dargaville, c. 1000 ft.	2.7	1.0	1.4	.8	.6	6
AK	Kirk, 183.	Mahurangi	3.5	1.3	.8	1.0	.7	6
AK	Kirk, 11448.	,,	4.4	1.3	1.2	1.3	.7	9
WELT	Kirk, —.	,,	4.3	1.3	1.2	1.1	.7	8
WELT	Kirk, 1014.	,,	4.4	1.3	1.2	.8	.6	7
WELT	Petrie, 13.	near Auckland	3.0	1.2	1.2	1.0	.7	7
WELT	Petrie, 5587.	Rangitoto Is.	3.6	1.4	.8	1.1	.5	5
WELT	Petrie, —.	,,	4.1	1.4	1.2	1.2	.7	8
WELT	Cheeseman, —.	,,	3.4	1.6	1.3	1.0	.6	7
WELT	Cheeseman, —.	Waitakerei	3.2	1.3	.8	1.0	.6	5
AK	Petrie, 5578.	Opaheke	2.5	.9	1.3	.8	.6	6
WELT	———	Mt. Karioi	3.4	1.6	1.5	.6	.5	7
CHR	Zotov, 4201.	Waingawa River	3.8	1.7	1.5	1.2	.6	7
WELT	Hurie, —.	Mt. Matthews	3.6	1.7	1.1	.9	.6	6
WELT	Aston, —.	Kapiti Is.	3.0	1.3	1.0	1.1	.6	5
CHR	Atkinson, 11557.	York Bay, Wellington	2.4	.8	.6	1.0	.6	5
CHR	Poole, 68486.	Hills above Eastbourne	4.0	1.2	1.5	1.1	.8	8
WELT	Buchanan, —.	Wellington	3.6	1.2	1.2	.9	.8	7
WELT	Kirk, 1018.	,,	3.1	1.4	1.6	1.1	.8	8
WELT	Kirk, —.	North Is.	3.5	1.4	1.8	1.3	.6	8
WELT	Kirk, 5586.	,,	2.8	1.1	1.5	1.2	.6	6
CHR	Mackay, 60065.	New River, 8 miles south of Greymouth	4.0	1.5	1.0	1.2	.6	6

M. robusta A. Cunn. var *retusa* T. Kirk

AK	Kirk, 5582.	Lowry Bay	2.6	1.6	2.3	1.1	.7	10
WELT	Kirk, 1021.	,,	2.4	1.6	2.1	1.2	.7	10

Table II.

Collection of flowering specimens from the southern slope of Rangitoto Island between reference points 377666 and 375674 of the N.Z. Lands and Survey Motutapu map of 1943 (1:25,000 series).

The measurements for leaf length, leaf width, internode length, stamen length and calyx length of this collection were published in my first paper on *Pohutukawa* x *Rata* in *Rec. Auck. Inst. Mus.* 4(4):210, 1954. The hybrid index numbers for the specimens are:

No.	Hybrid Index Number	No.	Hybrid Index Number	No.	Hybrid Index Number
1	13	13	17	25	13
2	15	14	13	26	14
3	14	15	14	27	13
4	12	16	17	28	13
5	14	17	14	29	12
6	14	18	14	30	13
7	15	19	16	31	14
8	12	20	15	32	10
9	7	21	13	33	14
10	12	22	12	34	11
11	14	23	14	35	15
12	12	24	14		

Table III.

Collection of flowering specimens from the eastern slope of Rangitoto Island between reference points 382688 and 394692 on the N.Z. Lands and Survey Motutapu map of 1943 (1:25,000 series).

The measurements for leaf length, leaf width, internode length, stamen length and calyx length of this collection were published in *Rec. Auck. Inst. Mus.* 4(4):211, 1954. The hybrid index numbers are:

No.	Hybrid Index Number	No.	Hybrid Index Number	No.	Hybrid Index Number
41	14	53	13	65	16
42	5	54	16	66	13
43	13	55	14	67	14
44	8	56	6	68	14
45	10	57	14	69	14
46	12	58	14	70	12
47	13	59	15	71	14
48	13	60	14	72	10
49	8	61	13	73	12
50	13	62	10	74	12
51	12	63	8	75	11
52	13	64	13		

Table IV.

Collection of flowering specimens from Blockhouse Bay between reference points 245503 (Wattle Bay) and 224508 (Te Whau Pt.) on the N.Z. Lands and Survey Titirangi map of 1944 (1:25,000 series).

Column 1. Leaf length
2. Leaf width
3. Internode length

Column 4. Stamen length
5. Calyx length
6. Hybrid index number

No.	1	2	3	4	5	6	No.	1	2	3	4	5	6
81	6.7	2.1	2.1	2.3	.9	16	83	8.1	2.6	1.6	3.3	1.2	18
82	5.7	2.3	1.5	2.3	.8	12	84	7.1	2.6	1.6	2.4	1.0	15

85	6.4	3.0	1.3	3.3	.9	15
86	7.3	2.5	1.4	2.7	1.0	14
87	5.7	2.8	1.5	3.0	1.0	14
88	5.0	2.9	1.3	3.1	1.1	15
89	8.1	3.1	1.8	2.6	.8	16
90	8.9	3.0	1.6	2.7	1.0	16
91	7.2	2.2	2.0	3.1	1.0	17
92	7.1	2.5	2.0	2.9	1.1	18
93	6.8	2.5	1.4	2.6	1.1	15
94	6.6	2.3	1.0	2.9	.9	14
95	6.4	1.8	1.9	2.9	1.2	16
96	5.1	2.3	1.7	2.5	.9	14
97	5.7	2.1	1.6	2.1	1.0	14
98	6.0	2.3	1.1	2.4	.9	13
99	6.8	2.3	1.3	2.5	1.2	15
100	8.0	2.7	1.4	1.8	.8	13
101	6.5	3.0	1.7	2.0	1.0	14
102	7.4	2.9	1.2	2.8	.9	14
103	7.3	2.4	1.8	2.3	.9	15
104	7.1	2.6	1.5	2.3	.8	13
105	7.3	2.9	1.7	2.7	.9	15
106	6.0	2.3	1.3	1.7	.8	12
107	7.0	2.0	1.1	1.9	.8	10
108	6.5	3.5	1.8	2.5	1.0	16
109	6.1	2.8	2.1	2.1	1.0	16
110	7.4	2.5	2.0	2.3	.8	15
111	6.9	2.6	1.8	2.8	1.0	15
112	6.5	2.9	1.4	2.3	1.1	15
113	6.6	2.5	1.2	2.0	.7	12
114	7.4	2.6	1.4	2.0	.8	12
115	5.0	2.4	1.9	2.6	1.0	14

Table V.

Collection of flowering specimens gathered by Mrs. P. Hynes on Mayor Island.

Column 1. Leaf length
2. Leaf width
3. Internode length

Column 4. Stamen length
5. Calyx length
6. Hybrid index number

No.	1	2	3	4	5	6
121	7.7	2.2	2.1	2.7	1.0	16
122	7.8	2.2	1.9	2.5	1.0	15
123	7.4	2.0	1.8	2.8	1.1	15
124	7.7	2.3	1.8	2.7	1.0	15
125	8.3	2.9	2.1	2.5	1.0	17
126	7.6	2.3	1.7	2.3	.9	15
127	8.2	2.6	1.9	2.6	1.0	16
128	7.8	2.2	1.8	2.6	1.0	15

Table VI.

Collection of flowering specimens from the Bay of Plenty between reference points N46-6521 (Opotiki Beach) and N52-2359 (Whanarua Bay) on the N.Z. Lands and Survey four-mile sheet No. 7, 1942.

Column 1. Leaf length
2. Leaf width
3. Internode length

Column 4. Stamen length
5. Calyx length
6. Hybrid index number

No.	1	2	3	4	5	6
131	7.4	3.0	1.4	2.3	1.1	15
132	5.9	2.4	1.5	2.2	1.0	13
133	4.1	2.0	1.3	1.8	.8	10
134	7.3	2.6	2.0	2.6	1.0	16
135	8.3	2.6	1.7	2.7	1.2	17
136	5.8	2.3	1.9	1.9	1.1	14
137	6.8	2.3	1.7	2.2	1.0	15
138	7.5	3.1	2.7	2.4	1.0	17
139	4.1	2.2	1.1	2.1	.8	11
140	6.2	3.4	1.7	2.6	1.0	16
141	5.3	2.0	1.4	2.7	.8	11
142	7.3	2.9	2.1	2.5	1.0	16
143	6.8	3.4	1.5	2.3	1.0	15
144	7.6	1.9	1.6	2.0	.8	12
145	5.5	2.5	1.8	2.4	.7	13
146	9.8	3.6	2.0	2.5	1.0	18
147	7.9	2.9	1.4	1.9	.8	12
148	7.7	3.0	1.6	2.3	1.1	16
149	7.6	3.6	2.5	2.0	1.1	17
150	8.1	3.0	2.2	2.1	1.1	18
151	6.7	2.7	1.4	2.2	1.0	14
152	6.8	2.3	1.6	2.1	.9	15
153	5.5	2.9	1.3	2.6	.9	13
154	6.7	2.5	1.4	2.0	.9	13
155	5.8	2.6	1.8	1.9	.9	13
156	7.2	3.2	2.3	2.2	1.2	18
157	7.9	3.9	1.5	2.7	1.1	16
158	8.2	3.1	2.2	2.9	1.0	19
159	7.1	3.1	1.9	3.0	1.1	18
160	7.1	3.1	2.1	2.0	.9	16
161	7.2	2.4	1.9	2.0	1.1	15
162	8.7	3.0	1.4	2.7	1.1	16
163	6.9	3.3	1.6	2.4	1.1	17
164	7.9	2.6	1.9	2.2	1.0	15
165	7.9	3.8	3.6	2.7	1.1	18

Table VII.

Collection of flowering specimens gathered by Mr. R. H. Ward at Lake Taupo.

Column 1. Leaf length
2. Leaf width
3. Internode length

Column 4. Stamen length
5. Calyx length
6. Hybrid index number

No.	1	2	3	4	5	6	No.	1	2	3	4	5	6
171	4.6	1.6	1.3	1.2	.6	8	178	4.4	1.6	1.6	1.8	.9	12
172	2.5	1.1	1.0	1.0	.7	6	179	4.3	1.7	1.3	2.0	1.0	11
173	5.2	1.8	.9	1.6	.7	9	180	5.6	2.0	1.2	2.0	.9	11
174	4.7	1.6	1.3	1.5	.6	9	181	6.4	1.9	1.1	1.5	.7	10
175	3.4	1.3	1.4	1.1	.6	6	182	3.5	1.2	1.4	1.5	.8	8
176	4.1	1.2	.9	1.3	.5	7	183	5.4	2.5	1.3	1.9	.9	12
177	3.4	1.3	1.0	1.6	.6	6	184	4.3	1.8	1.1	1.6	.8	9

Table VIII.

Collection of flowering specimens gathered by the N.Z. Forest Service near Westport.

Column 1. Leaf length
2. Leaf width
3. Internode length

Column 4. Stamen length
5. Calyx length
6. Hybrid index number

No.	1	2	3	4	5	6	No.	1	2	3	4	5	6
191	3.2	1.3	1.1	.7	.5	5	197	4.3	1.5	1.4	1.0	.6	7
192	3.8	1.5	1.9	.9	.7	8	198	3.9	1.3	.9	.8	.6	5
193	3.9	1.3	1.4	1.0	.7	7	199	2.9	1.1	1.0	.8	.6	5
194	4.0	1.4	1.1	1.1	.6	6	200	3.6	1.4	.7	.7	.6	5
195	3.1	1.3	1.3	.8	.6	6	201	4.1	1.5	1.3	1.2	.7	8
196	2.2	1.0	1.1	.8	.6	5	202	3.2	1.2	.8	1.0	.6	5

Table IX.

Fruiting specimens of *Metrosideros* in New Zealand herbaria.

Column 1. Leaf length
2. Leaf width
3. Internode length

Column 4. Capsule length
5. Capsule width
6. Hybrid index number

M. excelsa Sol. ex Gaertn. ("Pohutukawa")

Herbarium	Collector	Locality	1	2	3	4	5	6
AK	Banks & Solander, —.		8.1	2.6	2.1	1.1	.8	15
WELT	ex Col. Mus. Herb.	Kawau Is.	7.0	2.5	1.2	1.0	1.0	13
WELT	Petrie, —.	Rangitoto Is.	6.4	2.7	1.8	1.2	1.1	16
CHR	Petrie, 11562.	,,	7.1	3.0	3.7	1.3	.8	15
WELT	Petrie, —.	Orakei Point	6.3	2.6	1.9	1.1	.9	14
WELT	Kirk, 1012.	Auckland	6.3	2.0	1.6	1.2	.9	14
WELT	——	Hals garden, Thames River	5.7	2.2	1.5	1.1	1.0	12
WELT	——	Tauranga	5.5	2.6	1.6	1.2	1.1	15

M. x *subtomentosa* Carse

Herbarium	Collector	Locality	1	2	3	4	5	6
WELT	Petrie, —.	Rangitoto Is.	5.6	1.8	1.4	1.2	.7	11
WELT	Petrie, 5595.	,,	4.2	1.5	1.5	1.3	.7	10

M. robusta A. Cunn. ("Rata")

WELT	Kirk, 1015.	Whangaroa Harbour	3.4	1.0	1.6	.8	.5	7
WELT	Petrie, —.	8 miles north of Opanake, Taiheke Rd. near Kaihu, c. 1000 ft.	2.9	1.0	1.3	.7	.3	6
WELT	Petrie, —.		3.0	.9	1.2	.8	.4	6
WELT	Kirk, 1014.	Mahurangi	2.9	1.2	1.5	1.0	.5	7
WELT	Cheeseman, —.	Rangitoto Is.	3.1	1.5	1.3	.9	.5	6
WELT	Kirk, 1016.	„	2.9	1.0	1.5	.8	.5	6
WELT	Petrie, —.	„	3.7	1.4	1.4	.7	.5	6
WELT	Kirk, 294.	Thames	3.4	1.0	1.0	.8	.4	5
WELT	Kirk, 1017.	Thames goldfields	3.2	1.3	1.0	.7	.4	5
CHR	Zotov, 84209	Te Mara, Tararuas	2.8	1.1	.7	.8	.4	5
CHR	Zotov, 48702.	Education Reserve, Mt. Bruce	3.9	1.2	1.1	.8	.4	5
CHR	Zotov, 6462.	Tokomaru Falls, Tararuas	2.7	1.2	1.3	.7	.3	6
CHR	Poole, 63705.	Wairongomai Valley	3.5	1.0	.9	.9	.4	5
CHR	Mason, 64070.	Mt. Hawtrey, behind Eastbourne	2.4	.8	.7	.8	.4	5
CHR	Atkinson, 11557.	York Bay	3.5	1.3	1.4	.9	.4	6
WELT	Aston, —.	South Karori	3.1	1.4	1.6	.8	.4	7
AK	Matthews, 5579.	West Wanganui, Nelson	3.3	1.2	1.0	.7	.4	5
WELT	Matthews, —.	„ „ „	3.3	1.2	.8	.9	.5	5
AK	Townson, 5580-1.	Near Westport	3.4	1.3	1.3	.9	.5	6
CHR	Mackay, 60065.	New River, 8 miles south of Greymouth	3.5	1.3	1.4	.9	.4	6

Table X.

Collection of fruiting specimens from the southern slope of Rangitoto Island between reference points 377666 and 375674 of the N.Z. Lands and Survey Motutapu map of 1943 (1:25,000 series).

Column 1. Leaf length
2. Leaf width
3. Internode length
4. Capsule length
5. Capsule width
6. Hybrid index number

No.	1	2	3	4	5	6
211	7.9	3.1	2.5	1.6	1.2	19
212	6.7	2.0	1.6	1.1	1.0	13
213	6.6	1.9	1.6	.9	1.0	12
214	4.8	2.1	1.1	1.4	1.0	13
215	9.3	3.4	1.4	1.3	1.0	16
216	8.4	3.1	1.9	1.3	1.2	18
217	5.2	2.4	1.4	1.4	1.1	15
218	6.1	2.2	1.2	.9	.9	12
219	5.6	2.0	1.1	.9	.7	8
220	6.3	2.7	2.0	1.0	1.0	15
221	6.8	2.0	1.2	1.3	1.2	14
222	7.6	2.8	1.8	1.1	.9	14
223	5.5	1.9	1.7	1.2	.9	13
224	7.0	2.2	1.3	1.2	1.1	15
225	5.5	3.0	1.3	1.1	1.1	13
226	4.6	1.6	1.1	1.0	.5	8
227	7.1	2.5	1.7	1.1	.8	13
228	7.4	2.6	1.2	1.4	1.1	16
229	7.1	2.2	1.6	1.2	1.1	16
230	4.6	1.6	1.1	1.0	.8	9
231	7.4	2.7	1.4	1.4	1.1	16
232	6.7	2.2	1.2	.9	.9	12
233	7.4	2.4	1.5	1.2	1.1	15
234	6.0	2.0	1.0	1.3	1.0	12
235	7.8	2.5	1.0	1.3	1.1	14
236	7.9	2.6	1.2	1.3	1.1	15
237	8.1	3.3	1.8	1.3	1.1	18
238	5.7	2.5	1.4	1.1	1.0	12
239	6.9	2.8	2.0	1.2	1.0	16
240	8.8	3.1	1.5	1.0	1.0	15
241	7.7	2.3	2.1	1.6	1.1	18
242	7.9	2.4	1.9	1.2	1.0	15
243	6.7	2.4	1.6	1.3	1.1	16
244	7.7	2.5	1.9	1.2	1.0	15
245	4.8	1.7	.7	1.2	.8	10

Table XI.

Collection of fruiting specimens from the eastern slope of Rangitoto Island between reference points 382688 and 394692 on the N.Z. Lands and Survey Motutapu map of 1943 (1:25,000 series).

Column 1. Leaf length
2. Leaf width
3. Internode length

Column 4. Capsule length
5. Capsule width
6. Hybrid index number

No.	1	2	3	4	5	6	No.	1	2	3	4	5	6
251	3.9	1.6	1.2	.9	.8	8	269	6.3	2.8	1.2	1.0	1.1	14
252	5.4	1.5	1.7	1.1	1.0	11	270	5.9	2.4	1.3	1.2	1.0	13
253	5.9	2.7	1.0	1.1	1.0	11	271	5.1	2.0	2.1	1.2	.7	13
254	4.8	2.2	1.2	1.1	.9	12	272	7.0	2.9	1.2	1.3	1.1	15
255	4.8	2.6	1.3	1.1	1.1	13	273	5.1	2.4	1.2	1.1	.9	12
256	5.1	1.5	1.1	1.1	.8	8	274	6.1	2.6	1.4	1.1	1.1	14
257	5.2	1.7	1.0	1.2	.7	10	275	4.4	2.0	1.4	1.1	.9	11
258	4.4	1.5	1.1	1.1	.8	8	276	7.2	2.8	1.5	1.3	1.1	15
259	4.8	1.8	1.2	.9	.9	10	277	7.5	3.5	1.6	1.3	1.0	16
260	6.3	2.5	1.4	1.2	1.1	15	278	6.8	2.2	1.3	1.4	1.0	15
261	5.4	1.8	1.6	1.2	.8	12	279	6.3	2.6	1.2	1.1	1.0	13
262	6.8	2.5	1.2	1.1	1.1	14	280	5.1	2.1	1.5	1.0	1.0	12
263	5.5	2.3	1.2	1.1	1.0	12	281	6.1	2.5	1.5	.9	1.0	12
264	6.6	2.8	1.5	1.3	1.0	14	282	5.6	1.9	.9	1.2	1.0	11
265	5.9	2.1	1.2	1.4	.9	14	283	8.7	3.6	1.5	1.3	1.3	17
266	5.7	2.1	.9	1.1	1.0	11	284	6.6	2.1	1.7	1.0	1.0	14
267	5.6	2.2	1.3	1.3	1.0	13	285	3.3	1.2	.6	.9	.5	5
268	5.5	2.2	1.3	1.0	1.0	12							

Table XII.

Collection of fruiting specimens from Blockhouse Bay between reference points 245503 (Wattle Bay) and 224508 (Te Whau Pt.) on the N.Z. Lands and Survey Titirangi map of 1944 (1:25,000 series).

Column 1. Leaf length
2. Leaf width
3. Internode length

Column 4. Capsule length
5. Capsule width
6. Hybrid index number

No.	1	2	3	4	5	6	No.	1	2	3	4	5	6
291	6.9	2.6	1.6	.9	.9	13	309	6.0	2.4	1.6	1.2	1.1	16
292	7.9	2.8	1.6	1.3	1.1	16	310	6.5	2.6	1.4	.9	1.0	12
293	8.5	3.2	1.7	1.3	1.1	18	311	5.6	2.2	1.5	1.1	1.0	12
294	8.2	2.6	1.6	1.2	1.3	17	312	6.5	2.4	1.5	1.3	1.0	14
295	6.7	2.5	1.9	1.3	1.0	15	313	7.6	2.8	2.1	1.4	1.3	18
296	8.2	3.3	2.1	1.4	1.2	20	314	7.7	2.2	1.8	1.2	1.0	15
297	6.2	2.4	1.7	1.1	1.2	15	315	7.6	2.3	1.4	1.2	1.2	15
298	5.7	2.0	2.7	1.2	1.1	15	316	7.9	2.5	1.6	1.2	1.3	16
299	8.8	3.0	2.1	1.4	1.1	19	317	7.8	2.9	1.4	1.3	1.2	15
300	7.6	3.2	1.7	.9	1.0	14	318	7.2	2.4	1.4	1.2	1.0	14
301	10.9	3.4	1.5	1.0	.8	14	319	6.2	2.6	1.5	1.2	1.0	14
302	6.9	2.2	1.8	1.2	1.1	16	320	10.7	3.8	2.7	1.3	1.3	19
303	6.4	2.4	1.4	1.2	1.2	15	321	8.8	3.2	1.8	1.2	1.1	18
304	6.4	2.2	1.7	1.1	1.2	15	322	6.8	2.6	1.7	1.3	1.2	16
305	5.9	2.2	2.1	1.2	1.1	16	323	8.3	2.7	1.5	1.1	1.1	15
306	6.9	2.3	1.9	1.1	.8	13	324	8.0	3.1	1.5	1.3	1.1	17
307	7.9	2.9	1.6	.9	.8	12	325	5.5	2.8	2.6	1.1	1.0	14
308	7.1	2.2	1.5	1.0	1.1	14							

Table XIII.

Collection of fruiting specimens gathered by Mrs. P. Hynes on Mayor Island.

Column 1. Leaf length
2. Leaf width
3. Internode length

Column 4. Capsule length
5. Capsule width
6. Hybrid index number

No.	1	2	3	4	5	6	No.	1	2	3	4	5	6
331	6.0	2.4	1.5	1.2	1.2	15	336	7.1	2.6	1.4	1.4	1.1	16
332	8.0	2.3	1.9	1.3	1.1	17	337	7.7	3.2	1.4	1.2	1.3	16
333	6.0	2.7	2.1	1.4	1.1	18	338	7.2	2.8	2.1	1.4	1.2	18
334	5.8	2.4	1.4	1.4	1.1	15	339	8.9	3.4	2.2	1.1	1.1	18
335	8.0	2.4	1.7	1.3	1.0	16	340	8.1	3.0	1.8	1.1	1.1	16

Table XIV.

Collection of fruiting specimens gathered by Mr. T. Wilson on Mayor Island.

Column 1. Leaf length
2. Leaf width
3. Internode length

Column 4. Capsule length
5. Capsule width
6. Hybrid index number

No.	1	2	3	4	5	6	No.	1	2	3	4	5	6
341	9.1	3.3	1.5	1.4	1.0	17	359	8.0	2.4	1.6	1.3	1.1	17
342	7.3	2.8	1.7	1.4	1.1	17	360	7.9	3.8	2.1	1.5	1.2	19
343	8.0	3.6	1.5	1.6	1.1	18	361	8.7	2.5	1.4	1.4	1.2	17
344	7.4	2.4	1.2	1.5	1.1	16	362	7.7	3.0	1.2	1.2	1.1	15
345	7.1	2.7	1.6	1.5	1.0	16	363	7.1	2.3	1.6	1.3	1.2	16
346	7.0	3.5	3.5	1.8	1.2	19	364	8.9	3.9	2.4	1.6	1.1	20
347	6.9	3.3	2.3	1.8	1.3	19	365	6.4	2.7	1.8	1.3	1.0	15
348	9.2	3.9	1.9	1.7	1.1	19	366	7.6	3.7	2.2	1.7	1.3	19
349	7.3	3.4	3.0	1.7	1.2	19	367	9.5	4.4	2.4	1.6	1.1	20
350	8.0	3.8	2.5	1.5	1.1	20	368	7.8	3.4	1.4	1.3	1.2	16
351	6.6	3.4	2.8	1.6	1.3	19	369	6.1	2.6	1.3	1.2	1.2	15
352	8.8	4.4	2.5	1.6	1.1	20	370	8.0	3.8	2.6	1.6	1.2	20
353	7.9	4.0	3.5	1.7	1.2	19	371	6.5	2.9	2.5	1.6	1.2	18
354	8.4	4.1	2.8	1.7	1.1	20	372	8.2	4.1	2.1	1.6	1.1	20
355	7.0	2.8	1.5	1.3	1.3	15	373	7.6	3.8	1.4	1.5	1.2	17
356	7.0	2.7	2.3	1.3	1.1	17	374	6.5	3.3	2.6	1.5	1.1	19
357	9.3	2.7	1.8	1.5	1.1	18	375	8.0	2.2	1.7	1.7	1.1	18
358	6.9	2.9	2.1	1.4	1.1	18							

Table XV.

Collection of fruiting specimens from the Bay of Plenty between reference points N46-6521 (Opotiki Beach) and N52-2359 (Whanarua Bay) on the N.Z. Lands and Survey four-mile sheet No. 7, 1942.

Column 1. Leaf length
2. Leaf width
3. Internode length

Column 4. Capsule length
5. Capsule width
6. Hybrid index number

No.	1	2	3	4	5	6	No.	1	2	3	4	5	6
381	5.7	2.3	1.3	1.4	1.0	14	390	7.1	2.3	2.1	1.1	1.1	16
382	6.1	2.8	1.3	1.1	.9	13	391	6.1	2.9	2.5	1.1	.9	15
383	7.8	2.4	1.7	1.3	1.1	16	392	5.9	2.4	1.8	1.9	1.0	15
384	7.9	2.7	1.9	1.1	1.0	14	393	8.8	2.9	1.7	1.2	1.0	16
385	5.7	2.3	1.7	1.3	1.0	14	394	6.6	2.4	1.8	1.6	1.0	16
386	6.0	2.7	2.0	1.3	1.1	17	395	7.5	2.9	2.3	1.4	1.2	18
387	7.3	2.7	2.1	1.2	1.0	16	396	6.0	1.9	1.6	1.3	1.0	14
388	6.8	3.1	2.1	1.2	1.2	18	397	7.1	2.9	2.4	1.3	1.1	17
389	7.1	3.0	2.7	1.1	1.1	16	398	5.7	2.7	2.1	1.3	1.0	15

399	7.5	3.0	1.4	1.1	1.1	14	408	9.0	3.3	2.4	1.3	1.0	18
400	6.3	2.5	1.8	1.2	1.0	15	409	6.2	2.7	1.7	1.1	1.0	14
401	6.5	2.5	1.7	1.3	1.1	16	410	6.8	2.4	1.7	1.2	1.2	16
402	7.1	3.1	2.4	1.4	1.1	19	411	6.2	2.2	2.0	1.1	1.0	15
403	6.5	2.6	1.8	1.2	1.0	15	412	8.2	2.5	1.7	1.0	1.0	15
404	7.0	3.1	1.4	1.4	1.0	16	413	7.0	2.7	1.4	1.1	1.0	13
405	7.0	2.7	2.5	1.1	1.0	15	414	6.3	2.4	1.5	1.2	1.0	14
406	8.2	3.2	2.5	1.2	1.1	19	415	7.2	3.2	2.3	1.4	1.1	19
407	5.4	2.3	1.5	1.0	1.0	12							

Table XVI.

Collection of fruiting specimens gathered by Mr. R. H. Ward at Lake Taupo.

Column 1. Leaf length
2. Leaf width
3. Internode length

Column 4. Capsule length
5. Capsule width
6. Hybrid index number

No.	1	2	3	4	5	6	No.	1	2	3	4	5	6
421	4.2	1.5	1.5	.8	.5	7	425	6.2	1.9	1.3	.9	.7	10
422	3.4	1.6	1.2	.8	.4	7	426	4.6	1.4	1.1	.6	.6	6
423	3.6	1.3	1.2	.9	.7	7	427	4.2	1.5	1.1	.9	.7	7
424	5.9	1.9	1.4	.6	.7	9							

Table XVII.

Collection of fruiting specimens gathered by the N.Z. Forest Service near Westport.

Column 1. Leaf length
2. Leaf width
3. Internode length

Column 4. Capsule length
5. Capsule width
6. Hybrid index number

No.	1	2	3	4	5	6	No.	1	2	3	4	5	6
431	2.7	1.2	1.5	.8	.4	6	436	3.4	.9	1.3	1.0	.4	7
432	4.3	1.4	1.8	.7	.4	8	437	3.3	1.3	1.2	.9	.4	6
433	4.3	1.2	.9	1.0	.5	7	438	3.6	1.2	1.0	.8	.4	5
434	3.1	1.3	1.1	.8	.4	5	439	3.0	1.4	1.2	1.0	.4	7
435	3.3	1.3	1.3	1.0	.4	7	440	4.0	1.6	1.1	.7	.3	7

REFERENCES.

ALLAN, H. H., 1937. Wild species—hybrids in the Phanerogams. Bot. Rev. 3:593-615.

ANDERSON, E., 1949. Introgressive hybridization. Wiley, New York, 109 pp.

ANDERSON, E., 1953. Efficient and inefficient methods of measuring specific differences, in Kempthorne, 0 *et al,* Statistics and mathematics in biology. Iowa State College Press, Ames. 632 pp.

ATKINSON, I. A. & C. A. PERCY [1956]. An account of the vegetation of Mayor Island. Tane 7:29-34.

BELL, J. M., 1914. The wilds of Maoriland. Macmillan, London, 257 pp.

CARSE, H., 1927. Botanical notes, with descriptions of new species. *Trans N.Z. Inst.* 57:89-93.

CHEESEMAN, T. F., 1891. Further notes on the Three Kings Islands. *Trans. N.Z. Inst.* 23:408-424.

CHEESEMAN, T. F., 1922. Rangitoto Island and its vegetation, in New Zealand Nature Notes. Short sketches of the Geology, Botany . . . of New Zealand . . . for the use of members of the Australasian Association for the Advancement of Science, Wellington Meeting, January, 1923. Government Printer, Wellington, 64 pp.

CHEESEMAN, T. F., 1925. Manual of the New Zealand Flora. Ed. 2. Government Printer, Wellington, 1163 pp.

COCKAYNE, L., 1926. Monograph on the New Zealand beech forests. Part I. The ecology of the forests and taxonomy of the beeches. Government Printer, Wellington, 71 pp.

COLENSO, W., 1844. Journal of a naturalist in some little known parts of New Zealand. *Lond. Jour. Bot.* 3:1-62.

COOPER, R. C., 1954a. Pohutukawa x Rata. Variation in *Metrosideros* (Myrtaceae) on Rangitoto Island, New Zealand. *Rec. Auck. Inst. Mus.* 4(4):205-211.

COOPER, R. C., 1954b. Variation in *Hebe* (Scrophulariaceae) at Huia and Blockhouse Bay, New Zealand. *Rec. Auck. Inst. Mus.* 4(5):295-308.

CRANWELL, L. M. & L. B. MOORE, 1935. Botanical notes on the Hen and Chicken Islands. *Rec. Auck. Inst. Mus.* 1(6):301-318.

DE BERG, R. F., 1945. Some observations on *Metrosideros excelsa* Sol. ex. Gaertn. ("Pohutukawa"). Fam. Myrtaceae. M.Sc. thesis (Unpub.) Auckland University College.

FLETCHER, H. J., 1915. Notes on comparatively recent changes in the vegetation of the Taupo district. *Trans. N.Z. Inst.* 47:70-72.

GOLD-SMITH, E. C., 1885. Description of Mayor Island. *Trans. N.Z. Inst.* 17:417-427.

GRANGE, L. I., 1932. Taupo earthquakes, 1922. *N.Z. Jour. Sci. Tech.* 14:139-141.

HILL, H., 1905. Taupo Plateau and Lake; a retrospect and prospect. *Trans. N.Z. Inst.* 37:445-464.

HOCHSTETTER, F. von., 1867. New Zealand, its physical geography, geology and natural history. J. G. Cotta, Stuttgart, 515 pp.

KERRY-NICOLLS, J. H., 1884. The King Country. Sampson Low, Marston *et al*, London, 379 pp.

KIRK, T., 1879. Notes on the botany of Waiheke, Rangitoto and other islands in the Hauraki Gulf. *Trans. N.Z. Inst.* 11:444-454.

KIRK, T., 1889. The forest flora of New Zealand. Government Printer, Wellington, 345 pp.

KIRK, T., 1897. Notes on the botany of the East Cape District. *Trans. N.Z. Inst.* 29:509-532.

LOTSY, J. P., 1925. Evolution considered in the light of hybridization. Andrews, Baty & Co., Christchurch, 67 pp.

MILLENER, L. H., 1953. Second annual report of the New Zealand Ecological Society, pp 17-18.

SIBLEY, G. C., 1950. Species formation in the Red-eyed Towhees of Mexico. *Univ. Calif. Publ. Zool.* 50:109-194.

SIBLEY, G. C., 1954. Hybridization in the Red-eyed Towhees of Mexico. *Evolution* 8:252-290.

STEBBINS, G. L., 1950. Variation and evolution in plants. Columbia University Press, New York, 643 pp.

STEBBINS, G. L. & L. FERLAN, 1956. Population variability, hybridization, and introgression in some species of *Ophrys*. *Evolution* 10:32-46.

THOMSON, J. A., 1926. Geological notes on Mayor Island. *N.Z. Jour. Sci. Tech.* 8:210-214.

TOWNSON, W., 1907. On the vegetation of the Westport District. *Trans. N.Z. Inst.* 39:380-433.

WARD, R. H., 1922. A note on the significance of the recent subsidence of the shore of Lake Taupo. *N.Z. Jour. Sci. Tech.* 5:280-281.

WILLETT, R. W., 1950. The New Zealand Pleistocene snow line, climatic conditions, and suggested biological effects. *N.Z. Jour. Sci. Tech.* 32:18-48.